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The following communications were read :—

I. "Spectroscopic Observations of the Sun."—No. V. By J. Norman Lockyer, F.R.S. Received July 8, 1869. (See p. 74.)

II. "Researches on Gaseous Spectra in relation to the Physical Constitution of the Sun, Stars, and Nebulæ."—Third Note. By E. Frankland, F.R.S., and J. Norman Lockyer, F.R.S. Received July 14, 1869. (See p. 79.)

III. "On the successive Action of Sodium and Iodide of Ethyl on Acetic Ether." By J. Alfred Wanklyn, F.C.S. &c. Communicated by Professor Williamson. Received July 16, 1869. (See p. 91.)

## IV. "On Linear Differential Equations." By W. H. L. Russell, F.R.S. Received November 13, 1869.

The condition that the linear differential equation

$$(\alpha+\beta x+\gamma x^2)\frac{d^2u}{dx^2}+(\alpha'+\beta' x+\gamma' x^2)\frac{du}{dx}+(\alpha''+\beta'' x+\gamma'' x^2)u=0$$

admits of an integral $u=\epsilon^{\int\phi dx}$, where $\phi$ is a rational function of $(x)$, is given by the system of equations

$$\left\|\begin{array}{cccccccc} \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ 0\ldots P_{r-1} & Q_{r-1} & R_{r-1} & S_{r-1} & 0 & 0 & \ldots & 0 \\ 0\ldots 0 & P_r & Q_r & R_r & S_r & 0 & \ldots & 0 \\ 0\ldots 0 & 0 & P_{r+1} & Q_{r+1} & R_{r+1} & S_{r+1} & \ldots & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \end{array}\right\| = 0$$

where $P_r$, $Q_r$, $R_r$, $S_r$ are given as follows.

When $\alpha$, $\beta$, $\gamma$ are none of them equal to zero, and

$$\rho^2\gamma-\rho\gamma'+\gamma''=0,$$
$$P_r=\rho^2\beta-\{2\gamma(r-1)+\beta'\}\rho+(r-1)\gamma'+\beta',$$
$$Q_r=\rho^2\alpha-(2\beta r+\alpha')\rho+\gamma r(r-1)+\beta' r+\alpha'',$$
$$R_r=(r+1)(-2\rho\alpha+\beta r+\alpha'),$$
$$S_r=\alpha(r+1)(r+2).$$

There will be $(n+2)$ horizontal and $(n+1)$ vertical rows, where $n$ is the index of the highest power of $x$ in the denominator of $\phi$.

When $\alpha$ and $\beta$ are not zero but $\gamma=0$, and we put

$$\mu=\frac{\beta'}{\beta}-\frac{\gamma''}{\gamma'}-\frac{\alpha\gamma'}{\beta^2}, \quad \nu=\frac{\gamma'}{\beta},$$

then

$$P_r=\beta\mu^2+2\alpha\mu\nu-\beta'\mu-(r\beta+\alpha')\nu+\beta'',$$
$$Q_r=\alpha\mu^2-(2\beta r+\alpha')\mu-(2r+1)\alpha\nu+\alpha''+r\beta',$$
$$R_r=(r+1)(\beta r-2\alpha\mu+\alpha'),$$
$$S_r=\alpha(r+1)(r+2).$$

When $\alpha$ is not zero, but $\beta=\gamma=0$, and we put

$$\mu=\frac{\alpha'}{\alpha}\quad\frac{\gamma''}{\gamma'}, \quad \nu=\frac{\beta'}{\alpha}, \quad \rho=\frac{\gamma'}{\alpha},$$
$$P_r=\alpha\mu\nu-\alpha'\nu-\alpha(r+1)\rho+\beta'',$$
$$Q_r=\alpha\mu^2-\alpha'\mu-\nu\alpha(r+1)+\alpha'',$$
$$R_r=(r+1)(\alpha'-2\alpha\mu),$$
$$S_r=\alpha(r+1)(r+2).$$

Similar methods will apply to the linear differential equation

$$(\alpha+\beta x+\gamma x^2)\frac{d^3u}{dx^3}+(\alpha'+\beta'x+\gamma'x^2)\frac{d^2u}{dx^2}+(\alpha''+\beta''x+\gamma''x^2)\frac{du}{dx}$$
$$+(\alpha'''+\beta'''x+\gamma'''x^2)\alpha=0,$$

and the process admits of a very remarkable simplification. All linear differential equations of the second and third orders may be treated in the same way, and, I believe, all linear differential equations of every degree*.

V. "Spectroscopic Observations of the Solar Prominences, being Extracts from a Letter addressed to Sir J. F. W. Herschel, Bart., F.R.S., by Captain Herschel, R.E., dated 'Bangalore, June 12th and 15th, 1869.'" Communicated by Sir J. Herschel. Received July 19, 1869. (See p. 62.)

* This investigation assumes that $\alpha+\beta x+\gamma x^2$ and the denominator of $\phi$ have no common factor.—W. H. L. R., Jan. 13, 1869.